Problem #1

Two charged particles, Q_1 and Q_2, are a distance r apart with $Q_2 = 5Q_1$. Compare the forces they exert on one another when $\vec{F}_1$ is the force Q_2 exerts on Q_1 and $\vec{F}_2$ is the force Q_1 exerts on Q_2.

a) $\vec{F}_2 = 5\vec{F}_1$.
b) $\vec{F}_2 = -5\vec{F}_1$.
c) $\vec{F}_2 = -\vec{F}_1$.
d) $\vec{F}_2 = \vec{F}_1$.
e) $5\vec{F}_2 = \vec{F}_1$.

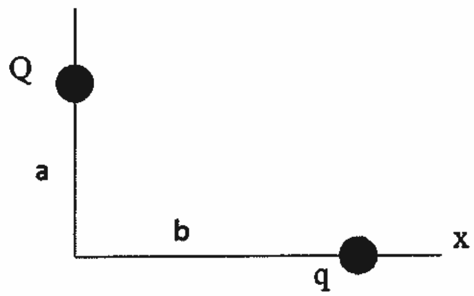
Problem #2

In the figure shown, if $Q = 30\ \mu C$, $q = 5.0\ \mu C$, and $d = 30$ cm, what is the magnitude of the electrostatic force on q?

a) 15 N
b) 23 N
c) zero
d) 7.5 N
e) 38 N

Problem #3

If $a = 3.0$ mm, $b = 4.0$ mm, $Q = 60$ nC, and $q = 32$ nC in the figure, what is the x component of the electric force on q?



a) $-0.41\ N$
b) $+0.41\ N$
c) $+0.69\ N$
d) $-0.55\ N$
e) $+0.55\ N$

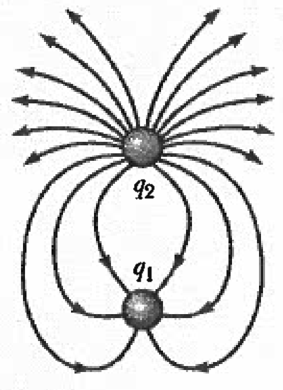
Problem #4

An electron is placed at rest in a uniform electric field of magnitude 520 N/C. The speed of the electron 48.0 ns after its release is:

a) 2.19×10^6 m/s
b) 3.44×10^6 m/s
c) 4.38×10^6 m/s
d) 6.78×10^6 m/s
e) 9.87×10^6 m/s

Problem #5

The figure shows the electric field lines for two charged particles separated by a small distance. The ratio of q_1/q_2 (include the sign)



a) - 2/3
b) + 1/3
c) - 1/4
d) - 1/3
e) + 4/9

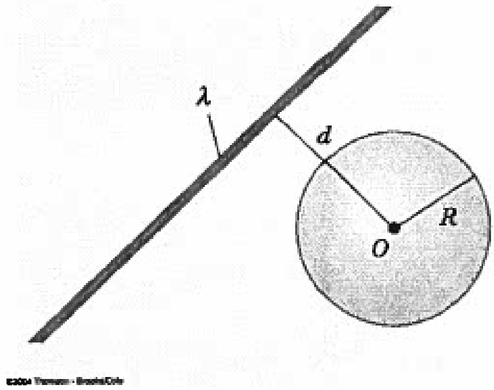
Problem #6

A uniformly charged conducting sphere of 1.2 m diameter has a surface charge density of 8.1 $\mu C/m^2$, the total electric flux leaving the surface of the sphere is:

a) 48.2×10^6 $N.m^2/C$
b) 9.65×10^6 $N.m^2/C$
c) 13.2×10^6 $N.m^2/C$
d) 4.14×10^6 $N.m^2/C$
e) 1.06×10^6 $N.m^2/C$

Problem #7

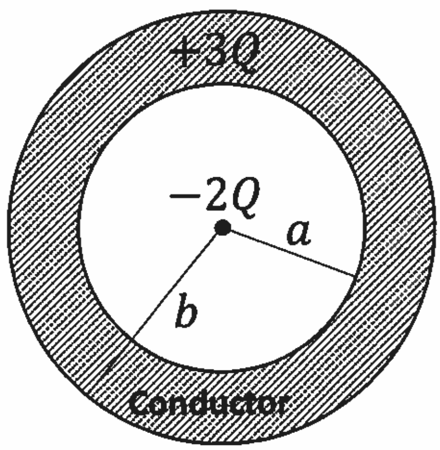
An infinitely long line charge having a uniform charge per unit length λ lies a distance d from point O as shown in the figure figure. The total electric flux through the surface of a sphere of radius R centered at O resulting from this line charge is, for R < d:



a) $\frac{\lambda}{4\pi\varepsilon_0}\sqrt{(d\char`^2) - R\char`^2}$
b) $\frac{4\lambda}{\varepsilon_0}$
c) 0
d) $\frac{\lambda}{2\pi\varepsilon_0}\sqrt{(d\char`^2) - R\char`^2}$
e) $\frac{\lambda}{2\varepsilon_0}$

Problem #8

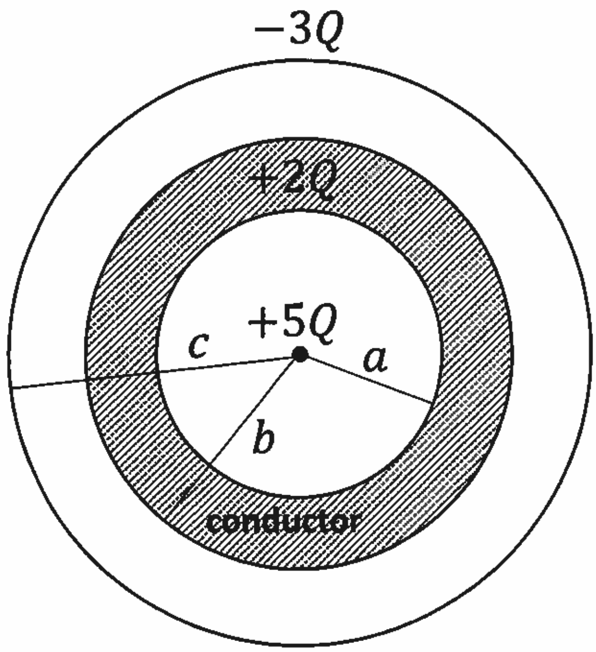
The figure below shows a negative point charge $-2Q$ at the origin. A conducting spherical shell of inner radius a, and outer radius b, with total charge $+3Q$ is concentric with the point charge. Assuming electrostatic equilibrium, the charge on the inner and outer surfaces of the conducting shell are:



a) $+3Q, 0$
b) $0, +3Q$
c) $-2Q, +5Q$
d) $+2Q, +Q$
e) $+2Q, -Q$

Problem #9

A point charge $+5Q$ is located at the origin. A conducting spherical shell, in electrostatic equilibrium, of inner radius a, and outer radius b is concentric with the point charge. The conductor has a total charge of $+2Q$. A thin spherical shell of radius c, and uniformly distributed negative charge $-3Q$ is also concentric with the point charge. The electric field at a radius $r > c$ is:



a) $\frac{5}{4}\left(\frac{Q}{\pi\epsilon_0 r^2}\right)$
b) $\left(\frac{Q}{\pi\epsilon_0 r^2}\right)$
c) $4\left(\frac{Q}{\pi\epsilon_0 r^2}\right)$
d) $2\left(\frac{Q}{\pi\epsilon_0 r^2}\right)$
e) $-\frac{3}{4}\left(\frac{Q}{\pi\epsilon_0 r^2}\right)$

Problem #10

An empty thick spherical aluminum shell of inner radius a and outer radius b carries a net negative charge $-Q$. In electrostatic equilibrium, the surface charge densities on the outer and inner surfaces are, respectively:

a) $-Q/4\pi a^2$, zero
b) $-Q/4\pi b^2$, zero
c) $-Q/8\pi b^2, -Q/8\pi a^2$
d) $Q/4\pi b^2, -2Q/4\pi a^2$
e) $-2Q/4\pi b^2, Q/4\pi a^2$

Problem #11

The electric field just above the surface of a charged conducting drum in electrostatic equilibrium of a photocopying machine has a magnitude of $2.3 \times 10^5 N/C$. What is the surface charge density on the drum?

a) $4.0\ \mu C/m^2$
b) Not enough info given
c) $2.0\ \mu C/m^2$
d) $1.0\ \mu C/m^2$
e) $3.0\ \mu C/m^2$

Problem #12

A 0.70 g piece of Styrofoam carries a net negative charge of $-0.700\ \mu C$ and is suspended in equilibrium above the center of a very large, horizontal sheet of plastic that has a uniform surface charge density. What is the charge per unit area on the plastic sheet?

a) $-347\ nC/m^2$
b) $-87\ nC/m^2$
c) $+347\ nC/m^2$
d) $+450\ nC/m^2$
e) $-173\ nC/m^2$

Problem #13

A positive point charge $Q_1 = 25 \times 10^{-6}$ C is fixed at the origin of the coordinates, and a negative point charge $Q_2 = -5 \times 10^{-6}$ C is fixed to the x axis at x = +2.0 m. The location of the place(s) along the x axis where the electric field of these two charges is zero is:

a) 3.6 m from Q_2, 1.6 m from Q_1
b) 1.6 m from Q_2, 3.6 m from Q_1
c) 0.31 m from Q_1, 2.31 m from Q_2
d) 0.31 m from Q_2, 2.31 m from Q_1
e) none of these

Problem #14

A uniform linear charge of 2.0 nC/m is distributed along the x axis from $x = 0$ to $x = 3$ m. Which of the following integrals is correct for the y component of the electric field at $y = 4$ m on the y axis?

a) $\int_0^3 \frac{72dx}{(16+x^2)^{3/2}}$

b) $\int_0^3 \frac{18dx}{(16+x^2)^{3/2}}$

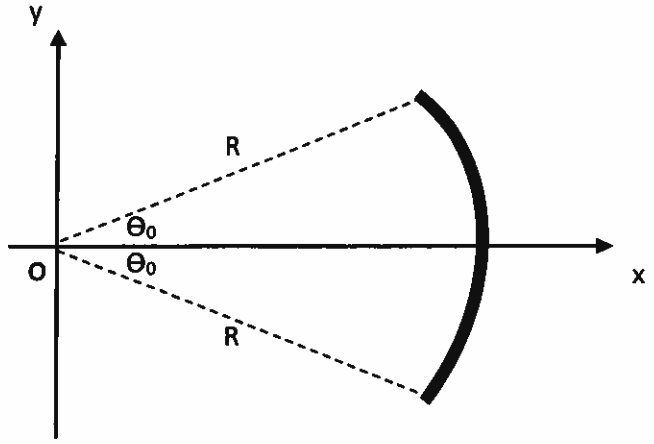
c) $\int_0^3 \frac{72dx}{16+x^2}$

d) $\int_3^0 \frac{18dx}{16+x^2}$

e) none of these

Problem #15

A thin rod is bent into the shape of an arc of a circle of radius R carries a uniform charge per unit length λ. The arc subtends a total angle of $2\,\Theta_0$, symmetric about the x axis, as shown. The electric field $\vec{E}$ at the origin is:

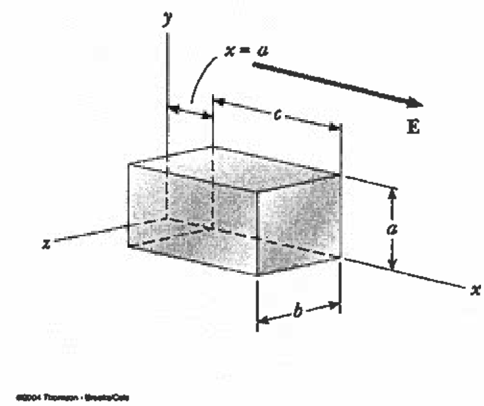


a) $[(-2\lambda\cos\Theta_0)/(4\pi\varepsilon_0 R)]\,\hat{j}$
b) $[(-2\lambda\cos\Theta_0)/(4\pi\varepsilon_0 R)]\,\hat{i}$
c) $[(-2\lambda\sin\Theta_0)/(4\pi\varepsilon_0 R)]\,\hat{j}$
d) $[(-2\lambda\sin\Theta_0)/(4\pi\varepsilon_0 R)]\,\hat{i}$

e) none of these

Problem #16

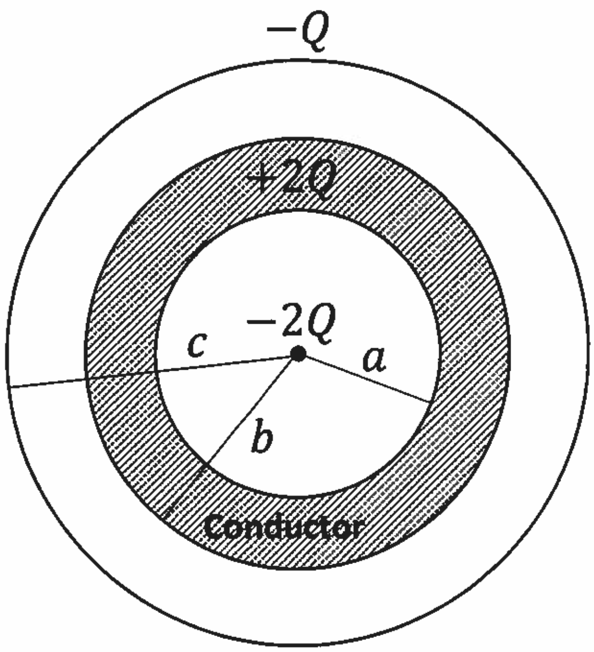
If a=b=0.4 m and c=0.6m, with the left edge of the closed surface located at x=a. If a non-uniform electric field $\vec{E} = (3.00 + 2.00\,x^2)\,\hat{i}$ is applied to the region, the net flux leaving the closed surface is given by:



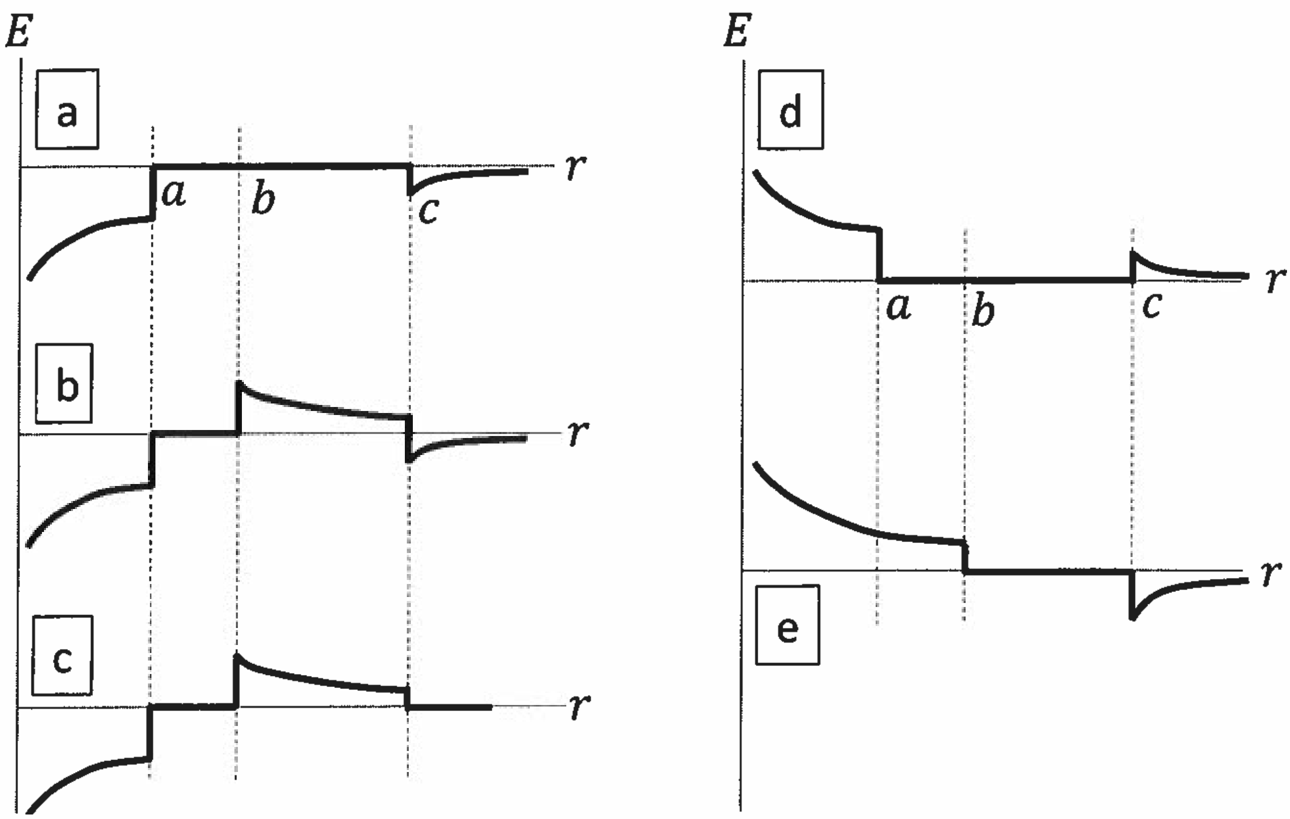
a) 0.269 $N.m^2/C$
b) 0.341 $N.m^2/C$
c) 0.678 $N.m^2/C$
d) 1.347 $N.m^2/C$
e) 0.045 $N.m^2/C$

Problem #17

A negative point charge $-2Q$ is located at the origin. A conducting spherical shell, in electrostatic equilibrium, of inner radius a, and outer radius b is concentric with the point charge. The conductor has a total charge of $+2Q$. A thin spherical shell of radius c, and uniformly distributed negative charge $-Q$ is also concentric with the point charge.



Which of the following plots describes the electric field as a function of distance from the center?



Problem #18

An infinite line of charge is coincident to the y-axis. The charge per unit length is given to be $-2nC/m$. What is the electric field at a point $(-2\ cm, 3\ cm)$?

a) -1800 N/C $\hat{\imath}$
b) -18 N/C $\hat{\imath}$
c) -1200 N/C $\hat{\imath}$
d) +1800 N/C $\hat{\imath}$
e) +1200 N/C $\hat{\imath}$

Problem #19

An infinitely long cylinder with uniform charge density ρ has a radius a. The electric field at a radius $r < a$ is

a) $\frac{\rho}{\epsilon_o}$

b) $\frac{\rho r}{\epsilon_o}$

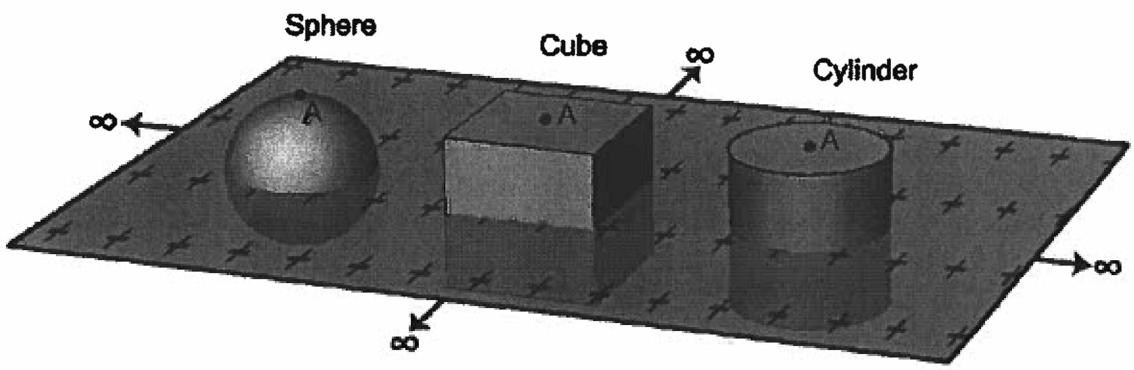
c) $\frac{\rho r}{2\epsilon_o}$

d) Zero

e) $\frac{\lambda}{2\pi\epsilon_o r}$

Problem #20

Consider three possible Gaussian surfaces (a sphere, a cube, and a cylinder) which extend half above and half below an infinite horizontal sheet of uniform charge density as shown in the figure below

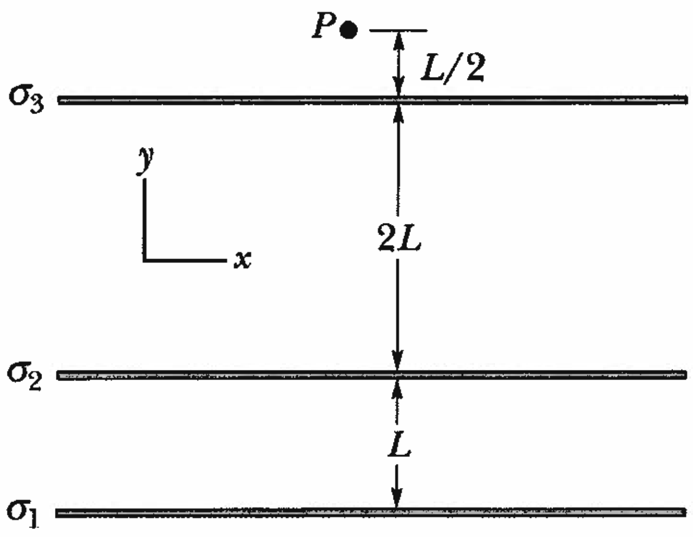


Point A is located at the top center of each Gaussian surface. For which of the Gaussian surfaces will Gauss's law help us to easily calculate the electric field at point A due to the sheet of charge?

a) Only the sphere, because it is symmetric enough
b) Only the cylinder, because the side walls have zero flux
c) Only the cylinder and the cube, because any shape with the side walls perpendicular to the sheet and end caps parallel to the sheet will work
d) Only the sphere and the cylinder, because they have circular cross sections
e) All surfaces will work since they are all symmetric

Problem #21

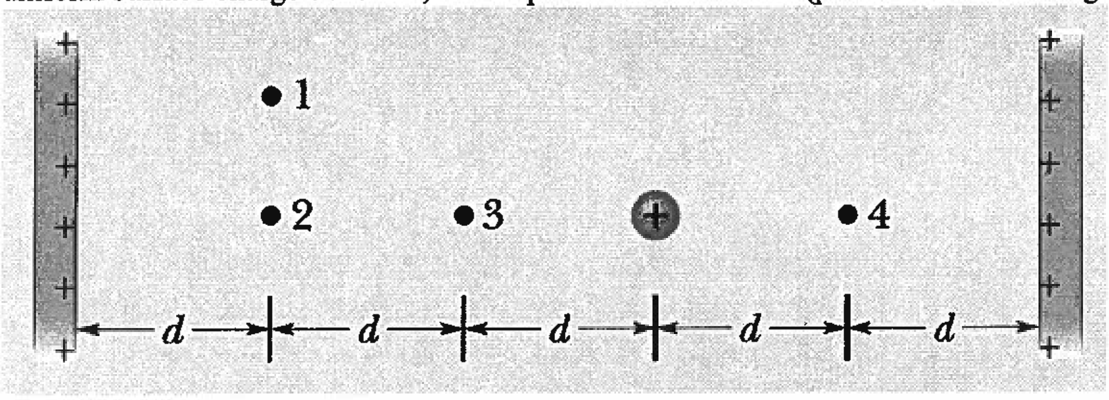
The following figure shows, in cross section, three infinitely large nonconducting sheets on which charge is uniformly spread. The surface charge densities are $\sigma_1 = +2.00\ \mu C/m^2$, $\sigma_2 = +4.00\ \mu C/m^2$, $\sigma_3 = -5.00\ \mu C/m^2$, and distance $L = 1.50\ cm$.



In unit vector notation, what is the net electric field at point P?
a) 0
b) $+(5.6 \times 10^4 N/C)\,\hat{j}$
c) $-(5.6 \times 10^4 N/C)\,\hat{j}$
d) $+(11.3 \times 10^4 N/C)\,\hat{j}$
e) $-(11.3 \times 10^4 N/C)\,\hat{j}$

Problem #22

The figure below shows two very large, parallel, nonconducting sheets with identical (positive) uniform surface charge densities, and a sphere with a uniform (positive volume charge density).



Rank the four numbered points according to the magnitude of the net electric field there, greatest first

a) 3=4, 1=2
b) 4, 3, 2, 1
c) 4=3, 1, 2
d) 4=3, 2, 1
e) 1, 2, 3, 4

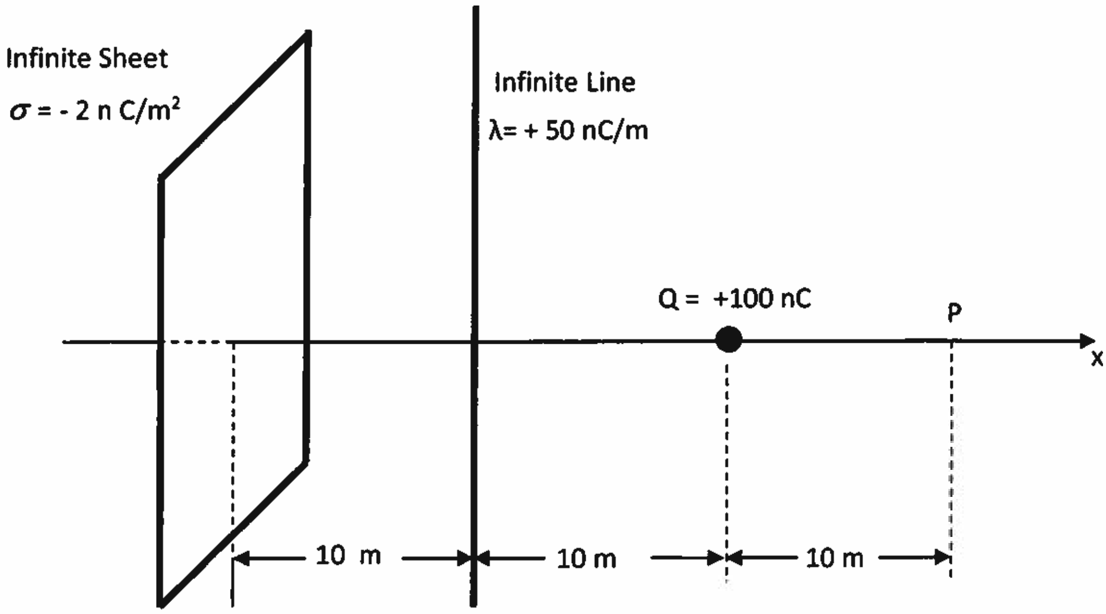
Problem #23

Two infinite lines of charge exist in the x-y plane. Both lines of charge are parallel to the x-axis. The first line of charge has a y-coordinate of +1 cm, and carries a charge per unit length of -2nC/m. the other line charge has a y-coordinate -3 cm, and has a linear charge density of +5nC/m. The electric field at a point (2 cm, -5 cm) is

a) -3900 N/C $\hat{j}$
b) +2700 N/C $\hat{j}$
c) 5100 N/C $\hat{j}$
d) -1500 N/C $\hat{j}$
e) +4360 N/C $\hat{j}$

Problem #24

A point charge, infinite line charge and infinite charged plane are arranged as shown in the figure. The total electric field at point p on the x axis is:



a) - 14.09 $\hat{\imath}$ N/C

b) + 14.09 $\hat{\imath}$ N/C

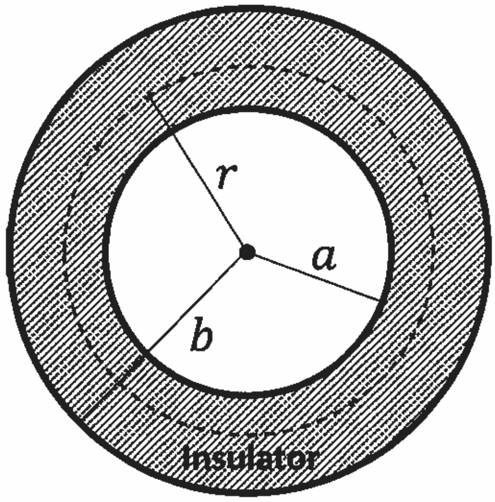
c) - 59.10 $\hat{\imath}$ N/C

d) + 59.10 $\hat{\imath}$ N/C

e) none of these

Problem #25

The following figure shows a uniformly charged insulating shell of inner radius a, and outer radius b, and total charge Q. Gauss's law states that $\oint \vec{E} \cdot d\vec{A} = \frac{q_{enclosed}}{\varepsilon_0}$. What is the right hand side of Gauss's law for the spherical Gaussian surface of radius r shown in the figure?



a) $\frac{\rho}{\epsilon_o}(4\pi r^2 - 4\pi a^2)$

b) $\frac{Q}{\epsilon_o}\frac{(r^3-a^3)}{b^3}$

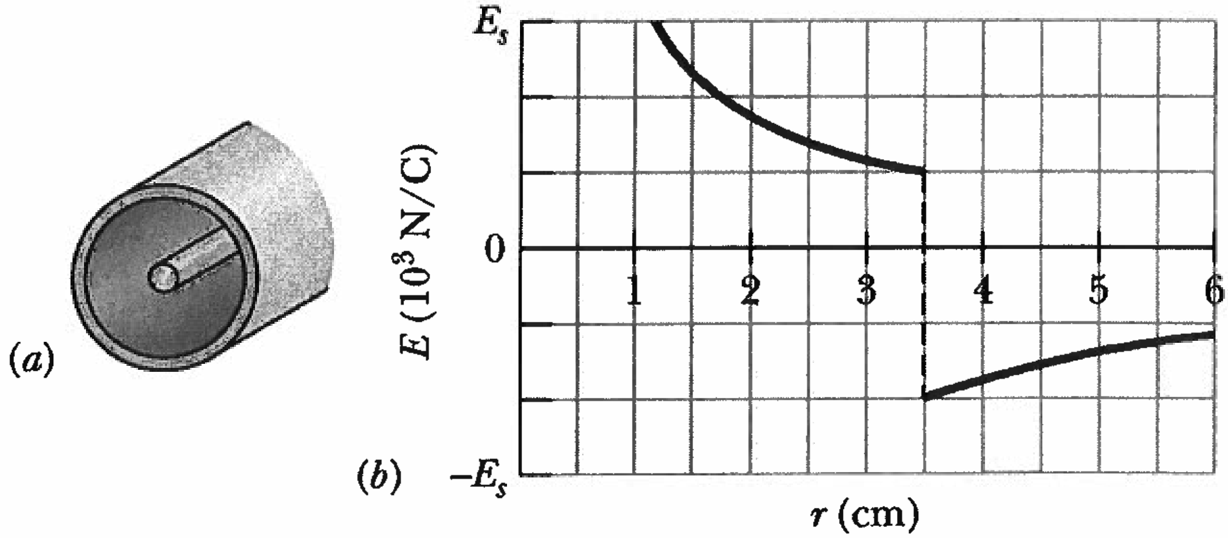
c) $\frac{Q}{\epsilon_o}\frac{(r^3-a^3)}{(b^3-a^3)}$

d) $\frac{r}{a}\frac{Q}{\epsilon_o}$

e) $\frac{\rho}{\epsilon_o}\frac{4}{3}\pi r^3$

Problem #26

The figure (a) below shows a long solid insulating cylinder and a long coaxial cylindrical shell. Figure (b) shows the electric field as a function of radial length with $E_s = 3 \times 10^3\ N/C$. The charge per unit length on the solid insulator is:



a) 5.30 nC/m

b) 1.94 nC/m

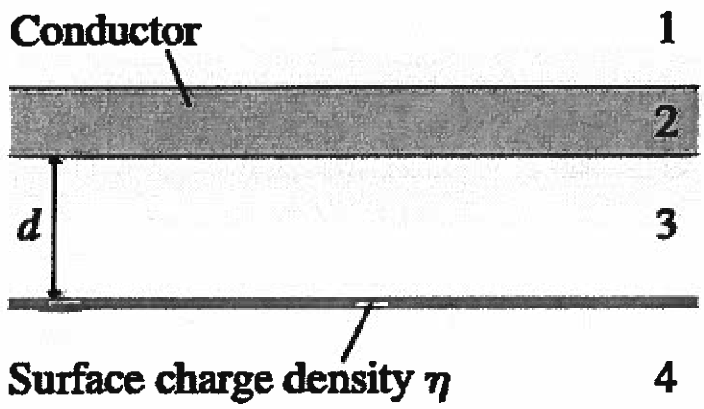
c) 0.80 nC/m

d) 7.43 nC/m

e) -2.50 nC/m

Problem #27

The figure below shows an infinitely large neutral conductor parallel to and distance d from an infinitely large plane of uniform surface charge density η.

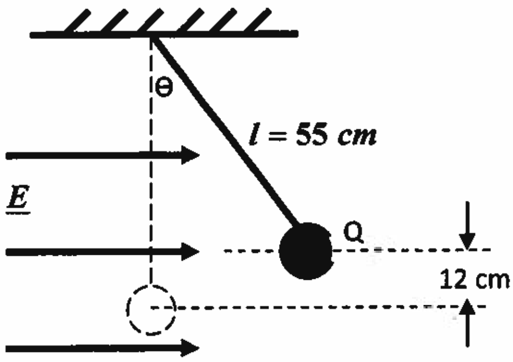


Assuming electrostatic equilibrium, what are the electric fields $\vec{E}_1$ to $\vec{E}_4$ in regions 1 to 4?

a) $\eta/\epsilon_0\hat{j}, 0, \eta/2\epsilon_0\hat{j}, -\eta/2\epsilon_0\hat{j}$
b) $\eta/2\epsilon_0\hat{j}, 0, \eta/2\epsilon_0\hat{j}, -\eta/\epsilon_0\hat{j}$
c) $\eta/2\epsilon_0\hat{j}, 0, \eta/\epsilon_0\hat{j}, -\eta/2\epsilon_0\hat{j}$
d) $\eta/2\epsilon_0\hat{j}, 0, -\eta/2\epsilon_0\hat{j}, -\eta/2\epsilon_0\hat{j}$
e) $\eta/2\epsilon_0\hat{j}, 0, \eta/2\epsilon_0\hat{j}, -\eta/2\epsilon_0\hat{j}$

Problem #28

A point charge (of mass = 1.0 g) at the end of an insulating cord of length 55 cm is observed to be in equilibrium in a uniform horizontal electric field of 15000 N/C and points to the right, when the pendulum's position is as shown with the particle 12 cm above the lowest vertical position, the value of the point charge is:



a) 5.20×10^{-7} C
b) 6.51×10^{-7} C
c) 5.20×10^{-4} C
d) 6.51×10^{-4} C
e) none of these

Problem #29

It is found experimentally that the electric field in a certain region of the Earth's atmosphere is directed vertically down. At an altitude of 300 m the field has magnitude 60.0 N/C ; at an altitude of 200 m, the magnitude is 100 N/C. The net amount of charge contained in a cube 100m on edge, with horizontal faces at altitudes of 200 m and 300 m is:

a) 1.76 μC
b) 3.54 μC
c) 9.04 μC
d) 6.32 μC
e) 0.78 μC

Problem #30

An uncharged nonconducting, hollow sphere of radius 10.0 cm surrounds a 10.0-μC charge located at the origin of a Cartesian coordinate system. A drill with a radius of 1.00 mm is aligned along the z-axis, and a hole is drilled in the sphere. The electric flux through the hole is:

a) 3.42 $N.m^2/C$
b) 92.8 $N.m^2/C$
c) 56.4 $N.m^2/C$
d) 14.1 $N.m^2/C$
e) 28.2 $N.m^2/C$

Problem #	**Answer**
1	C
2	D
3	E
4	C
5	D
6	D
7	C
8	D
9	B
10	B
11	C
12	E
13	B
14	A
15	D
16	A
17	A
18	D
19	C
20	C
21	B
22	D
23	A
24	C
25	C
26	B
27	E
28	A
29	B
30	E